

SCHIZOTYPAL TRAITS IN UNAFFECTED RELATIVES OF PATIENTS IN THE SCHIZOPHRENIA SPECTRUM

*Chrysoula Zouraraki, Leda Karagiannopoulou, Penny
Karamaouna, & Stella G. Giakoumaki*

University of Crete, Greece

Abstract: Schizotypy is defined as liability to schizophrenia, paralleling schizophrenic symptoms. Individuals with a family history of schizophrenia are at increased risk for illness development and their evaluation for schizotypy offers the advantage of examining the background of schizophrenia, while avoiding confounding variables. In this review, research findings regarding the expression of different schizotypal dimensions in unaffected relatives of patients with a diagnosis in the schizophrenia spectrum are summarized. The main findings indicate that first degree relatives express elevated negative schizotypy but results regarding positive and disorganized schizotypal dimensions are less established. Methodological considerations and future directions are discussed.

Keywords: schizotypy, schizotypal traits, relatives of patients in schizophrenia spectrum

INTRODUCTION

Schizophrenia is a complex psychiatric disorder, characterized by social (Dickerson, Boronow, Ringel, & Parente, 1999), cognitive (Heinrichs & Zakzanis, 1998) and generalized functional impairment (Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001). It manifests itself with a significant heterogeneity of clinical symptoms, disease course and outcome (Heckers, 2009) and has a multifactorial etiology, with multiple susceptibility genes interacting with environmental influences (Siever & Davis, 2004). One way to approach the liability to schizophrenia, avoiding the effects of confounding variables such as medication, institutionalization and illness chronicity, is

Address: Zouraraki Chrysoula, Department of Psychology, Faculty of Social Sciences, University of Crete, Gallos University Campus, Rethymno 74 100. Tel.: +30-28310-77541. E-mail: psyp172@psy.soc.uoc.gr

via the study of schizotypal traits in genetic high-risk populations, such as the unaffected first degree relatives of patients.

Schizotypy is a multidimensional concept related to the symptom clusters in schizophrenia (Bentall, Claridge, & Slade, 1989; Vollema & Van den Bosch, 1995) as the three schizotypal (i.e., positive, negative, disorganization) factors are considered to be analogous to the schizophrenic symptoms (reality distortion, psychomotor poverty, disorganization) introduced by Liddle (1987). In detail, positive schizotypal traits are similar to the positive symptoms of schizophrenia and include oddities in perception, magical thinking, ideas of reference and suspiciousness/paranoia; negative schizotypal traits are analogous to the negative symptoms of schizophrenia and refer to impoverished interpersonal relationships, constricted affect, excessive social anxiety; disorganized schizotypal traits include unusual speech and eccentric behavior and resemble the bizarre behavior and formal thought disorder observed in schizophrenia. Schizotypy is classically studied through two different approaches, namely the fully dimensional and the quasi-dimensional models. The fully dimensional model was formulated by Claridge (1997) and is based on the idea that schizotypy is a deviant but non-pathological personality trait, which indicates predisposition to psychosis, when exceeding a critical threshold. According to the quasi-dimensional model, schizotypy indicates proneness to psychosis and is part of the schizophrenia-spectrum (Meehl, 1962). This psychiatric viewpoint is based on the clinical observations of Rado (1953), who coined the term “schizotypy”; later on, Meehl (1962) proposed a model for the pathogenesis of schizophrenia, suggesting that both schizotypal and schizophrenic individuals share a common neurodevelopmental vulnerability path.

Schizotypal traits are assessed either with self-report questionnaires or through clinical and structured interviews. According to Vollema and Van den Bosch (1995) and Bentall et al. (1989) the psychometric scales for assessing schizotypy are heterogeneous and can be differentiated into (a) symptom-oriented, such as the Perceptual Aberrations scale, Social and Physical Anhedonia scales (Chapman, Chapman, & Raulin, 1976; Chapman, Chapman, & Raulin, 1978), Magical Ideation (Eckblad & Chapman, 1983) and Impulsive Nonconformity scales (Chapman et al., 1984); (b) syndrome-oriented, such as the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) and the Schizotypal Personality Scale (STA; Claridge & Broks, 1984) and (c) personality-oriented, such as the Eysenck Personality Questionnaire (EPQ; Eysenck, Eysenck, & Barrett, 1985) and the Minnesota Multiphasic Personality Inventory (MMPI) profile for schizotypal traits (Lachar, 1974). Clinical interviews, though, are considered more sensitive for the evaluation of schizotypal traits than self-report questionnaires (Catts, Fox, Ward, & McConaghy, 2000). Some widely used interviews for the evaluation of schizotypal symptoms are the Structured

Clinical Interview for DSM Axis II Disorders - module for schizotypal personality disorder (SCID; Spitzer, Williams, Gibbon, & First, 1990), the Interview for Prodromal Schizophrenia Syndromes (SIPS; Miller et al., 2002), and the Structured Interview for Schizotypy (SIS; Kendler, Lieberman, & Walsh, 1989).

As regards the etiology of schizotypy, although it is not fully clarified in the literature, a significant percentage (approximating 50%) is explained by genetic (Linney et al., 2003) and neuroanatomical factors (Diwadkar, Montrose, Dworakowski, Sweeney, & Keshavan, 2006; Rosso et al., 2010) related to schizophrenia (Ettinger, Meyhöfer, Steffens, Wagner, & Koutsouleris, 2014; Kendler et al., 1993). It is not surprising, therefore, that schizotypal traits are increased in both clinical (Rosell, Futterman, McMaster, & Siever, 2014) and genetic high-risk groups, such as the unaffected relatives of patients (Solanki, Swami, Singh, & Gupta, 2012). Interestingly, it has also been reported that the prevalence of positive or negative symptoms in schizophrenic probands predicts the type of schizotypal features in their unaffected relatives (Fanous, Gardner, Walsh, & Kendler, 2001). However, important environmental parameters, either “biological”, such as pre- and perinatal complications, winter/autumn birth (Lahti et al., 2009), low birth weight, obstetric complications (Foerster, Lewis, Owen, & Murray, 1991), or “psychosocial”, such as childhood trauma (Schürhoff et al., 2009), physical or sexual abuse (Steel, Marzillier, Fearon, & Ruddle, 2009), parental communication deviance (de Sousa, Varese, Sellwood, & Bentall, 2014), and sub-optimal parenting (Giakoumaki et al., 2013) have also been reported to increase the risk for the development of schizotypal traits. The interplay between genetics and environment is well documented in a recent study by Walder, Faraone, Glatt, Tsuang, and Seidman (2014) who proposed a ‘polygenic neurodevelopmental diathesis-stress model’. According to this model, the susceptibility for psychosis “*involves the independent and synergistic confluence of (temporally-sensitive) biological and environmental factors across development*” (p. 142).

Evidence about the familial aggregation of schizophrenia-like features was consistently provided by the Danish Adoption studies of Kety, Rosenthal, Wender, and Schulsinger (1968). Based on these studies Spitzer, Endicott, and Gibbon (1979) proposed the criteria (i.e., magical thinking, ideas of reference, social isolation, recurrent illusions, odd speech, inadequate rapport, suspiciousness and undue social anxiety) for a new diagnostic entity termed Schizotypal Personality Disorder (SPD), which was included in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III; American Psychiatric Association, 1980). These criteria were retained in the revisions of DSM (DSM IV, American Psychiatric Association, 1994 and DSM IV-TR, American Psychiatric Association, 2000) that followed. However, Section III of DSM 5th Edition (DSM-5, American Psychiatric Association,

2013) recently introduced significant changes in the diagnosis of SPD. More specifically, a new hybrid model introducing six personality disorder types, including SPD, was proposed. According to this model, personality traits are found in different degrees in every individual and personality disorders represent broad personality domains, which consist of specific maladaptive personality facets. The domains of Psychoticism (i.e., extensive range of odd behaviors/cognitions) and Detachment (i.e., avoidance of social/emotional experiences) are characteristic of the schizotypal personality and are adequately examined by all the scales assessing schizotypy: Positive and Disorganised Schizotypal traits are closely connected with Psychoticism and Negative Schizotypy maps well onto Detachment. Another significant addition in DSM 5 is the inclusion of Attenuated Psychosis Syndrome, which refers to the existence of “state-induced” sub-threshold psychosis-like experiences, which resemble closely schizotypal traits, accompanied by functional impairment. Having a family history of psychosis increases the risk of individuals with attenuated psychosis syndrome for developing psychotic disorders (American Psychiatric Association, 2013). Based on these innovative changes introduced in DSM 5, it is evident that the study of schizotypy in first-degree relatives of schizophrenia patients can further aid clinical practice in two ways: (a) more precise diagnostic criteria aiming to the early identification of individuals at risk for developing psychotic disorders can be developed and (b) both protective and compensating factors that could be incorporated into therapeutic approaches can be recognized.

To this end, although it has been repeatedly reported (Bora & Veznedaroglu, 2007; Calkins, Curtis, Grove, & Iacono, 2004; Docherty, Sponheim, & Kerns, 2015) that unaffected relatives of schizophrenia patients present with elevated schizotypal traits overall, studies examining which schizotypal dimension (i.e., Positive, Negative or Disorganized) prevails as well as studies examining the severity of schizotypal traits in this group of subjects have yielded discrepant findings. The aim of this review is to summarize these findings in order to further elucidate the topic. For this reason, we performed a PubMed and Scopus search with combinations of the keywords “schizotypal traits”, “schizotypy”, “schizotypal personality”, “relatives”, “parents”, “siblings”, “offspring”, “familial risk for schizophrenia”, “positive schizotypy”, “negative schizotypy”, “disorganized schizotypy”. The search covered publications from 1990 to August 2015. Studies were selected if they met the following criteria: written in English, participants were unaffected first degree relatives of patients within the schizophrenia spectrum, schizotypal traits were assessed with either psychometric self-report questionnaires or clinical interviews, there was a control group and/or a group of patients to be compared with the group of relatives. Based on these criteria, we identified twenty three studies, summarized in Table 1.

Table 1. Summary of reviewed studies

Study	Sample	Schizotypy Assessment	Group Differences
Appels et al. (2004)	Rel: $N = 72$; Con: $N = 52$	SPQ	CPS, Delusional atmosphere, Magical ideation: Rel < Con POS and NEG: Rel with FH > Rel without FH All p values < .05
Bollini et al. (2007)	Rel: $N = 26$; Con: $N = 38$	SCID Interview; SPQ	DIS: Con > Rel; $p < .05$
Bora et al. (2007)	Rel: $N = 94$; Con: $N = 75$	SPQ-B	SPQ Total and INT: Rel > Con All p values < .005
Calkins et al. (2004)	Rel: $N = 135$; Con: $N = 112$	SPQ; MMPI-2: Lie/defensiveness; PRF: Infrequency	SPQ Total, INT, Social Anxiety, Constricted Affect, No Close Friends, Unusual Perceptual Experiences: Rel > Con All p values < .05
Catts et al. (2000)	Rel: $N = 46$; Con1: Healthy $N = 38$ /Con2: Parents of patients with axis I diagnosis $N = 40$	PAS; PhysAnh; EPQ Psychoticism Scale	Psychoticism: Rel > Con1 Neuroticism: Con2 > Rel PAS: Rel < Con1 All p values < .05
Clementz et al. (1991)	Rel: $N = 148$; Con: $N = 178$	PAS; PhysAnh	PAS: Con > Rel PhysAnh: Rel > Con All p values < .001
Compton et al. (2007)	Rel: $N = 61$; Con: $N = 57$	SPQ-B	CPS, INT and DIS: Rel = Con
Craver et al. (1999)	Rel: $N = 39$; Con1: Control Siblings; $N = 38$; Con2: Control Probands: $N = 38$	SANS; Revised SocAnh	Negative SANS Symptoms and SocAnh: Rel = Con1 and Rel = Con2
De la Serna et al. (2011)	Rel: $N = 56$; Con: $N = 33$	SIPS	Positive, Disorganized, General and Total Symptoms: Rel > Con All p values < .05
Docherty et al. (2015)	Rel: $N = 33$; Con: $N = 25$	SAE	SocAnh and PAS: Rel > Con All p values < .05
Franke et al. (1993)	Rel: $N=26$; Con: $N=35$	PhysAnh; PAS	PhysAnh: Rel > Con; $p < .05$
Glatt et al. (2006)	Rel: $N = 35$; Con: $N = 55$	MIS; PAS; PhysAnh	PhysAnh: Rel > Con; $p < .005$
Groove et al. (1991)	Rel: $N = 61$; Con: $N = 18$	SSP; PhysAnh; PAS; MMPI	SocInt and PhysAnh: Rel > Con All p values < .05
Katsanis et al. (1990)	Rel: $N = 125$; Con: $N = 117$	PhysAnh; SocAnh; PAS	PhysAnh and SocAnh: Rel > Con PAS: Rel < Con All p values < .05
Kendler et al. (1995)	Rel: $N = 314$; Con: $N = 575$	SIS	Negative/Positive schizotypy, Social Dysfunction, Avoidant Symptoms, Odd Speech, Suspicious Behavior: Rel > Con All p values < .005

Continued

Table 1. (Continued)

Kimble et al. (2000)	Rel: $N = 15$; Con: $N = 15$	SIS	Schizotypy Levels: Rel = Con
Kremen et al. (1998)	Rel: $N = 40$; Con: $N = 44$	SPQ	CPS: Rel > Con; $p < .01$
Laurent et al. (2000)	Rel: $N = 47$; Con: $N = 34$	PhysAnh; SocAnh; PAS; MIS	PAS, PhysAnh, SocAnh, MIS: Rel = Con
Mata et al. (2000)	Rel: $N = 121$; SCZ patients: $N = 90$	KSQ; SAE; Modified IPDE for Cluster A Personality Disorders	Negative Schizotypy, Anhedonia, Having no close friends, Constricted Affect: M Rel > F Rel Schizotypal traits in SCZ patients correlated with KSQ Score in Rel and SAE All p values < .05.
Mata et al. (2003)	Rel: $N = 263$; Psychotic patients: $N = 172$	KSQ; SAE; Modified IPDE for Cluster A Personality Disorders	Anhedonia, Inappropriate Affect, Paranoid traits, No close friends: M Rel > F Rel IPDE Schizotypal traits: F Rel > M Rel Delusions-Hallucinations Syndrome in patients correlated positively with the three measures for schizotypy in Relatives All p values < .05
Solanki et al. (2012)	Rel: $N = 50$; Con: $N = 30$	SPQ-B	SPQ-B Total Score, CPS, INT: Rel > Con All p values < .001
Yaralian et al. (2000)	Rel: $N = 13$; Con1 (no FH of drug abuse & SCZ): $N = 51$ (44:7)/ Con2 (FH drug abuse): $N = 38$	SPQ	CPS: Rel > Con1 and Rel > Con2 Ideas of Reference and Unusual Perceptual Experiences: Rel > Con1 All p values < .05
Vollema et al. (2002)	Rel: $N = 117$; SCZ patients: $N = 51$	SPQ	CPS: Siblings and Offsprings > Parents All p values < .05

Con = Controls; Rel = Relatives; M = Males; F = Females; SCZ = Schizophrenia, SCT = Schizotypy; FH = Family History; SPQ = Schizotypal Personality Questionnaire; SPQ-B = Schizotypal Personality Questionnaire Brief Version; CPS = Cognitive-Perceptual Schizotypy Factor; INT = Interpersonal Schizotypy Factor; DIS = Disorganized Schizotypy Factor; POS = Positive Schizotypy; NEG = Negative Schizotypy; SCID Interview = Structured Clinical Interview for DSM-Module for schizotypal personality disorder; PRF = Personality Research Form; MMPI-2 = Minnesota Multiphasic Personality Inventory-2; EPQ = Eysenck Psychoticism Scale; SANS = Scale for the Assessment of Negative Symptoms; SIPS = Semi-structured Interview for Prodromal Schizophrenia Syndromes; SocInt = Social Interpersonal Factor; SSP = Schedule for Schizotypal Personalities; SIS = Structured Interview for Schizotypy; MIS = Magical Ideation Scale; PAS = Perceptual Aberration Scale; SocAnh = Social Anhedonia Scale; PhysAnh = Physical Anhedonia Scale; IPDE = Interview for Cluster A' Personality Disorders Examination; SAE = Survey of Attitudes and Experiences Scale; KSQ = Kings Schizotypy Questionnaire.

Positive schizotypal traits

Positive schizotypy includes symptoms such as magical ideation, ideas of reference, and unusual perceptual experiences (Raine, 1991). De la Serna et al. (2011) examined both offsprings and siblings of schizophrenic patients for positive, negative and disorganized symptoms, using the SIPS. Offsprings manifested higher positive symptoms in comparison with control subjects, while siblings manifested an increase only in disorganized symptoms. Studies employing the SPQ (Raine, 1991) have also revealed that relatives score significantly higher on the Positive Schizotypy factor compared with healthy controls (Kremen, Faraone, Toomey, Seidman, & Tsuang, 1998; Solanki et al., 2012; Yarialian et al., 2000). Vollema, Sitskoorn, Appels, and Kahn (2002) compared parents, siblings and offsprings of schizophrenic patients with the SPQ and found that both siblings and offsprings scored higher on positive schizotypy than parents. Laurent et al. (2000) and Docherty et al. (2015) administered the Chapman's scales (Chapman, Chapman & Raulin, 1978) and found a trend towards increased perceptual aberrations. Finally, in a study with the SIS Kendler, McGuire, Gruenberg, and Walsh (1995) reported increased positive schizotypy in the relatives' group.

Despite the aforementioned results, many studies support that either there is no difference in positive schizotypal traits or that relatives express lower positive schizotypal levels than controls. Thus, Appels, Sitskoorn, Vollema, and Kahn (2004) assessed parents of patients with schizophrenia and control parents of healthy individuals using the SPQ. They found that parents of patients scored lower on cognitive-perceptual schizotypy (an aspect of positive schizotypy), especially on the magical ideation subscale. Bollini et al. (2007) administered the SPQ and the SCID-II and found that relatives of schizophrenic patients and control individuals did not differ in either the number of cognitive-perceptual features or on the total score on the cognitive-perceptual dimension of the SPQ. Non-significant differences between relatives and controls in the expression of positive schizotypal traits have also been reported with the SPQ-Brief (Compton, Chien, & Bollini, 2007), the Perceptual Aberration Scale (Catts et al., 2000; Clementz, Grove, Katsanis, & Iacono, 1991; Katsanis, Iacono, & Beiser, 1990) and the SIS (Kimble et al., 2000).

Negative Schizotypal Traits

Negative schizotypy refers to sub-threshold symptoms such as constricted affect, excessive social anxiety and no close friends (Raine, 1991). There are many studies assessing the expression of negative schizotypy in unaffected relatives of

schizophrenic patients, using the Physical Anhedonia scale (Clementz et al., 1991; Franke, Maier, Hardt, Hain, & Cornblatt, 1993; Glatt, Stone, Faraone, Seidman, & Tsuang, 2006; Grove et al., 1991). All these studies concluded that this group has significantly elevated Physical Anhedonia compared with healthy controls. Similar findings have also been reported for Social Anhedonia (Docherty et al., 2015; Katsanis et al., 1990). Two studies (Mata et al., 2000; Mata et al., 2003) employed the Kings Schizotypy Questionnaire (KSQ; Williams, 1993) and the Survey of Attitudes and Experiences Scale (SAE; Wilkins, 1988) for the assessment of schizotypy in parents and siblings of patients. They both found elevated scores on KSQ Negative Schizotypy and on SAE Anhedonia with the male parents' and siblings' groups. Interestingly, high rates of premorbid schizoid-schizotypal traits in the schizophrenic probands were correlated with high total scores on the KSQ and the SAE in their relatives (Mata et al., 2000). Similar findings have been obtained with the SPQ, indicating that unaffected relatives have higher negative schizotypy compared with controls (Bora & Veznedaroglu 2007; Calkins et al., 2004; Solanki et al., 2012). Finally, in one study with the SIS, Kendler et al. (1995) also reported increased negative schizotypy in the relatives' group.

As with positive schizotypal traits, there are also studies which report non-significant differences between unaffected relatives and controls in negative schizotypy as assessed with the Scale for the Assessment of Negative Symptoms (SANS) and the Social Anhedonia Scale (Craver & Pogue-Quile, 1999), SIS (Kimble et al., 2000), SPQ and SCID-II (Bollini et al., 2007) as well as SPQ-Brief (Compton et al., 2007).

Disorganized schizotypal traits

Disorganized Schizotypy includes odd speech and odd/eccentric behavior (Raine, 1991). De la Serna et al. (2011) assessed offsprings and siblings of schizophrenic patients with the SIPS and found significantly increased disorganized symptoms. Moreover, Kendler et al. (1995) supported that relatives of schizophrenic probands can be distinguished from control subjects by their scores in odd speech, which is a trait highly associated with disorganization (Raine, 1991). In a study by Bollini et al. (2007), however, the control group had higher disorganized traits than the unaffected relatives, possibly due to the inclusion of a biased group of relatives, expressing fewer schizotypal traits. Finally, Compton et al. (2007) administered the SPQ-Brief and reported no differences between the group of relatives and controls.

DISCUSSION

The majority of the studies reviewed suggests that unaffected first-degree relatives of schizophrenia patients present with higher schizotypal traits compared to control individuals without a family history of psychosis. However, there is a critical number of studies that provide negative findings. More specifically, eight studies examining positive schizotypy report that the unaffected relatives present with higher schizotypal traits while another seven studies did not find any significant differences between this and the control group. In fact, Appels et al. (2004), Clementz et al. (1991) and Catts et al. (2000) support that the relatives experience even lower positive schizotypal traits. Possible explanations to this could be (a) the inclusion of biased groups of relatives (e.g., relatives who differed in response style); (b) that the questionnaires used are not sensitive enough in the detection of positive schizotypal traits and (c) that cognitive-perceptual schizotypy, which is a central aspect of positive schizotypy, is also part of what is described in the literature as “healthy” or “pseudo-schizotypy” (Mohr & Claridge, 2015; Raine, 2006) and may not be related to the genetic risk for schizophrenia (Torgersen, Onstad, Skre, Edvardsen, & Kringlen, 1993). Findings on disorganized schizotypy are inconclusive, as well. However, the lack of sensitivity of the psychometric instruments in the detection of disorganized traits has already been highlighted (Tarbox & Pogue-Geile, 2011) and studies examining this aspect of schizotypy in unaffected relatives are scarce.

Studies on negative schizotypy support that unaffected relatives experience higher negative schizotypal traits compared with control individuals. However, four studies failed to obtain statistically significant differences: Bollini et al. (2007) and Compton et al. (2007) argued that this is possibly due to the relatives responding in a defensive way, because of their heightened awareness of schizophrenia and the related sociocultural stigma; Craver and Pogue-Geile (1999) proposed that the lack of significant differences is due the inadequacy of the scale used in their study to identify mild deficits in the relatives as a result of floor effects, and the study of Kimble et al. (2000) evaluated a sample with small size. Based on the above, we could conclude that negative schizotypal traits are indeed increased in the unaffected relatives of schizophrenia spectrum patients, indicating a stronger familial association with schizophrenia (Tarbox & Pogue-Geile, 2011).

Overall, there are some additional methodological problems in the existing studies that need to be acknowledged. One limitation is the small sample size employed in several studies. According to Button et al. (2013) small sample sizes reduce the statistical power and the chance of detecting a true effect. Furthermore, inclusion and exclusion criteria for participation are diverse. For example, the lack of

prior psychiatric examination of the relatives, the absence of an assessment for intellectual functioning, substance abuse and pharmacological treatment could have a confounding effect in the findings. The absence of control groups matched for gender, age and education with the relatives is another methodological limitation. Notably, all these three factors have been associated with schizotypy (Bora & Arabaci, 2009; Miettunen et al., 2010; Raine, 1992).

Another important issue is that several studies evaluate schizotypy with the SPQ. One major criticism about the SPQ is its dichotomous forced choice format (true-false). Cohen, Matthews, Najolia, and Brown (2010) and Wuthrich and Bates (2005) used Likert versions of the SPQ and found greater sensitivity, better internal reliability and identified more high scorers for schizotypy, compared with the dichotomous version. Also, a four-factor model of the SPQ, where positive schizotypy is divided into paranoid and cognitive perceptual factors (Tsaousis, Zouraraki, Karamaouna, Karagiannopoulou, & Giakoumaki, 2015; Stefanis et al., 2004), better reflects the multidimensionality of schizotypal traits. Interestingly, this model has not thus far been used in studies as those described in the present review. Finally, regardless of the psychometric measure selected, assessments with self-report questionnaires always have the possibility of a defensive or socially desirable response style by the participant (Catts et al., 2000; Peltier & Walsh, 1990), further explaining the contradictory results reported.

To conclude, there is still need for further and more thorough assessments of the different schizotypal dimensions in unaffected relatives of patients in the schizophrenia spectrum. Thus, future studies should include larger samples, should employ stricter inclusion/exclusion criteria and well-defined demographic characteristics for the groups compared. Furthermore, the evaluation of environmental factors along with schizotypy could be informative about the expression of different schizotypal traits in high risk individuals. Future studies should also address the use of self-report questionnaires, in parallel with interview-based assessments for schizotypy.

REFERENCES

- American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: American Psychiatric Association.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders: DSM- IV* (4th ed.). Washington, DC: American Psychiatric Association.
- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed. Text rev.). Washington, DC: American Psychiatric Association. doi: 10.1176/dsm.10.1176/appi.books.9780890420249.

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing. doi: 10.1176/appi.books.9780890425596.
- Appels, M. C., Sitskoorn, M. M., Vollema, M. G., & Kahn, R. C. (2004). Elevated levels of schizotypal features in parents of patients with a family history of schizophrenia spectrum disorders. *Schizophrenia Bulletin*, *30*(4), 781-790. doi: 10.1093/oxfordjournals.schbul.a00713.
- Bentall, R. P., Claridge, G. S., & Slade, P., D. (1989). The multi-dimensional nature of schizotypal traits: A factor analytic study with normal subjects. *British Journal of Clinical Psychology*, *28*, 363-375. doi: 10.1111/j.2044-8260.1989.tb00840.x.
- Bollini, A. M., Compton, M. T., Esterberg, M. L., Rutland, J., Chien, V. H., & Walker, E. F. (2007). Associations between schizotypal features and indicators of neurological and morphological abnormalities. *Schizophrenia Research*, *92*(1-3), 32-40. doi: 10.1016/j.schres.2007.01.018.
- Bora, E., & Arabaci, L. B. (2009). Effect of age and gender on schizotypal personality traits in the normal population. *Psychiatry and Clinical Neurosciences*, *63*, 663-669. doi: 10.1111/j.1440-1819.2009.02011.x.
- Bora, E., & Veznedaroglu, B. (2007). Temperament and character dimensions of the relatives of schizophrenia patients and controls: the relationship between schizotypal features and personality. *European Psychiatry*, *22*(1), 27-31. doi: 10.1016/j.eurpsy.2006.07.002.
- Button, K. S., Ioannidis, J. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. J., & Munafö, M. R. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*, 365-376. doi: 10.1038/nrn3475.
- Calkins, M. E., Curtis, C. E., Grove, W. M., & Iacono, W. G. (2004). Multiple dimensions of schizotypy in first degree biological relatives of schizophrenia patients. *Schizophrenia Bulletin*, *30*(2), 317-325. doi: 10.1093/oxfordjournals.schbul.a00708.
- Catts, S. V., Fox, A. M., Ward, P. B., & McConaghy, N. (2000). Schizotypy: Phenotypic marker as risk factor. *Australian and New Zealand Journal of Psychiatry*, *34*(1), 101-107. doi: 10.1046/j.1440-1614.2000.00777.x.
- Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1976). Scales for physical and social anhedonia. *Journal of Abnormal Psychology*, *85*, 374-382. doi: 10.1037/0021-843X.85.4.374.
- Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1978). Body-image aberration in schizophrenia. *Journal of Abnormal Psychology*, *87*, 399-407. doi: 10.1037//0021-843X.87.4.399.
- Chapman, L. J., Chapman, J. P., Numbers, J. S., Edell, W. S., Carpenter, B. N., & Beckfield, D. (1984). Impulsive nonconformity as a trait contributing to the prediction of psychotic-like and schizotypal symptoms. *Journal of Nervous and Mental Disease*, *172*, 681-691. doi: 10.1097/00005053-198411000-00007.
- Claridge, G. S., & Broks, P. (1984). Schizotypy and hemisphere function: Theoretical considerations and the measurement of schizotypy. *Personality and Individual Differences*, *5*, 633-648. doi: 10.1016/0191-8869(84)90111-9.
- Claridge, G. (1997). *Schizotypy: Implications for illness and health*. New York, NY: Oxford University Press.
- Clementz, B. A., Grove, W. M., Katsanis, J., & Iacono, W. G. (1991). Psychometric detection of schizotypy: Perceptual aberration and physical anhedonia in relatives of schizophrenics.

- Journal of Abnormal Psychology*, 100(4), 607-612. doi: 10.1037/0021-843X.100.4.607.
- Cohen, A. S., Matthews, R. A., Najolia, G. M., & Brown, L. A. (2010). Toward a more psychometrically sound brief measure of schizotypal traits: Introducing the SPQ-brief revised. *Journal of Personality Disorders*, 24(4), 516-537. doi: 10.1521/pedi.2010.24.4.516.
- Compton, M. T., Chien, V. H., & Bollini, A. M. (2007). Psychometric properties of the brief version of the Schizotypal Personality Questionnaire in relatives of patient with schizophrenia-spectrum disorders and non-psychiatric controls. *Schizophrenia Research*, 91(1-3), 122-131. doi: 10.1016/j.schres.2006.12.005.
- Craver, J. C., & Pogue' Keile, M. R. (1999). Familial liability to schizophrenia: A sibling study of negative symptoms. *Schizophrenia Bulletin*, 25(4), 827-839. doi: 10.1093/oxford-journals.schbul.a033422.
- De la Serna, E., Baeza, I., Andrés, S., Puig, O., Sánchez-Guistau, V., Romero, S., ..., Castro-Fornieles, J. (2011). Comparison between young siblings and offspring of subjects with schizophrenia: Clinical and neuropsychological characteristics. *Schizophrenia Research*, 131(1-3), 35-42. doi: 10.1016/j.schres.2011.06.015.
- De Sousa, P., Varese, F., Sellwood, W., & Bentall, R. P. (2014). Parental communication and psychosis: A meta-analysis. *Schizophrenia Bulletin*, 40, 756-768. doi: 10.1093/schbul/sbt088.
- Dickerson, F., Boronow, J. J., Ringel, N., & Parente, F. (1999). Social functioning and neurocognitive deficits in outpatients with schizophrenia: A 2-year follow-up. *Schizophrenia Research*, 37, 13-20. doi: 10.1016/S0920-9964(98)00134-0.
- Diwadkar, V. A., Montrose, D. M., Dworakowski, D., Sweeney J. A., & Keshavan, M. S. (2006). Genetically predisposed offspring with schizotypal features: An ultra high-risk group for schizophrenia? *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 30, 230 - 238. doi: 10.1016/j.pnpbp.2005.10.019.
- Docherty, A. R., Sponheim, S. R., & Kerns, J. G. (2015). Self-reported affective traits and current affective experiences of biological relatives of people with schizophrenia. *Schizophrenia Research*, 161(2-3), 340-344. doi: 10.1016/j.schres.2014.11.013.
- Eckblad, M., & Chapman, L. J. (1983). Magical ideation as an indicator of schizotypy. *Journal of Consulting and Clinical Psychology*, 51, 215-225. doi: 10.1037/0022-006X.51.2.215.
- Ettinger, U., Meyhöfer, I., Steffens, M., Wagner, M., & Koutsouleris, N. (2014). Genetics, cognition, and neurobiology of schizotypal personality: A review of the overlap with schizophrenia. *Frontiers in Psychiatry*, 5(18), 1-16. doi: 10.3389/fpsy.2014.00018.
- Eysenck, S. B. G., Eysenck, H. J., & Barrett, P. (1985). A revised version of the psychoticism scale. *Personality and Individual Differences*, 6, 21-29. doi: 10.1016/0191-8869(85)90026-1.
- Fanous, A., Gardner, C., Walsh, D., & Kendler, K., S. (2001). Relationship between positive and negative symptoms of schizophrenia and schizotypal symptoms in nonpsychotic relatives. *Archives of General Psychiatry*, 58(7), 669-673. doi: 10.1001/archpsyc.58.7.669.
- Foerster, A., Lewis, S. W., Owen, M. J., & Murray, R. M. (1991). Low birth weight and a family history of schizophrenia predict poor premorbid functioning in psychosis. *Schizophrenia Research*, 5(1), 13-20. doi: 10.1016/0920-9964(91)90049-W.
- Franke, P., Maier, W., Hardt, J., & Hain, C. (1993). Cognitive functioning and anhedonia in

- subjects at risk for schizophrenia. *Schizophrenia Research*, *10*, 77-84. doi: 10.1016/0920-9964(93)90079-X.
- Giakoumaki, S. G., Roussos, P., Zouraraki, C., Spanoudakis, E., Mavrikaki, M., Tsapakis, E. M., & Bitsios, P. (2013). Sub-optimal parenting is associated with schizotypic and anxiety personality traits in adulthood. *European Psychiatry*, *28*(4), 254-260. doi: 10.1016/j.eurpsy.2012.07.002.
- Glatt, S. J., Stone, W. S., Faraone, S. V., Seidman, L. J., & Tsuang, M. T. (2006). Psychopathology, personality traits and social development of young first-degree relatives of patients with schizophrenia. *British Journal of Psychiatry*, *189*, 337-345. doi: 10.1192/bjp.bp.105.016998.
- Grove, W. M., Lebow, B. S., Clementz, B. A., Cerri, A., Medus, C., & Iacono, W. G. (1991). Familial prevalence and coaggregation of schizotypy indicators: A multitrait family study. *Journal of Abnormal Psychology*, *100*(2), 115-121. doi: 10.1037/0021-843X.100.2.115.
- Heckers, S. (2009). Neurobiology of Schizophrenia Spectrum Disorders. *Annals of the Academy of Medicine*, *38*(5), 431-432. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/19521644>
- Heinrichs, R. W., & Zakzanis, K. K. (1998). Neurocognitive deficit in schizophrenia: A quantitative review of the evidence. *Neuropsychology*, *12*, 426-445. doi: 10.1037/0894-4105.12.3.426.
- Katsanis, J., Iacono, W. G., & Beiser, M. (1990). Anhedonia and perceptual aberration in first-episode psychotic patients and their relatives. *Journal of Abnormal Psychology*, *99*(2), 202-206. doi: 10.1037/0021-843X.99.2.202.
- Kendler, K. S., Lieberman, J. A., & Walsh, D. (1989). The structured interview for schizotypy (SIS): A preliminary report. *Schizophrenia Bulletin*, *15*(4), 559-571. doi: 10.1093/schbul/15.4.559.
- Kendler, K. S., McGuire, M., Gruenberg, A. M., O'Hare, A., Spellman, M., & Walsh, D. (1993). The Roscommon family study: III. Schizophrenia-related personality disorders in relatives. *Archives of General Psychiatry* *50*, 781-788. doi: 10.1001/archpsyc.1993.01820220033004.
- Kendler, K. S., McGuire, M., Gruenberg, A. M., & Walsh, D. (1995). Schizotypal symptoms and signs in the Roscommon family study. Their factor structure and familial relationship with psychotic and affective disorders. *Archives of General Psychiatry*, *52*(4), 296-303. doi: 10.1001/archpsyc.1995.03950160046009.
- Kety, S. S., Rosenthal, D., Wender, P. H., & Schulsinger, F. (1968). The types and prevalence of mental illness in the biological and adoptive families of adopted schizophrenics. *Journal of Psychiatric Research*, *6*(1), 345-362. doi: 10.1016/0022-3956(68)90026-5.
- Kimble, M., Lyons, M., O'Donnell, B., Nestor, P., Niznikiewicz, M., & Toomey, R. (2000). The effect of family status and schizotypy on electrophysiologic measures of attention and semantic processing. *Biological Psychiatry*, *47*(5), 402-412. doi: 10.1016/S0006-3223(99)00184-5.
- Kremen, W. S., Faraone, S. V., Toomey, R., Seidman, L. J., & Tsuang, M. T. (1998). Sex differences in self-reported schizotypal traits in relatives of schizophrenic probands. *Schizophrenia Research*, *34*(1-2), 27-37. doi: 10.1016/S0920-9964(98)00081-4.

- Lachar, D. (1974). *The MMPI: Clinical assessment and automated interpretation*. Los Angeles, CA: Western Psychological Services.
- Lahti, J., Raikkönen, K., Sovio, U., Miettunen, J., Hartikainen, A., Pouta, A., ..., Veijola, J. (2009). Early-life origins of schizotypal traits in adulthood. *British Journal of Psychiatry*, *195*, 132-137. doi: 10.1192/bjp.bp.108.054387.
- Laurent, A., Biloa-Tang, M., Bougerol, T., Duly, D., Anchisi, A. M., Bosson, J. L., Pellat, J., d'Amato, T., & Dalery, J. (2000). Executive/attentional performance and measures of schizotypy in patients with schizophrenia and in their nonpsychotic first-degree relatives. *Schizophrenia Research*, *46*(2-3), 269-283. doi: 10.1016/S0920-9964(99)00232-7.
- Liddle, P. F. (1987). The symptoms of chronic schizophrenia: A re-examination of the positive-negative dichotomy. *British Journal of Psychiatry*, *151*, 145-151. doi: 10.1192/bjp.151.2.145.
- Linney, Y. M., Murray, R. M., Peters, E. R., MacDonald, A. M., Rijdsdijk, F., & Sham, P. C. (2003). A quantitative genetic analysis of schizotypal personality traits. *Psychological Medicine*, *33*, 803-816. doi: 10.1017/S0033291703007906.
- Mata, I., Sham, P. C., Gilvarry, C. M., Jones, P. B., Lewis, S. W., & Murray, R. M. (2000). Childhood schizotypy and positive symptoms in schizophrenic patients predict schizotypy in relatives. *Schizophrenia Research*, *44*(2), 129-136. doi: 10.1016/S0920-9964(99)00222-4.
- Mata, I., Gilvarry, C. M., Jones, P. B., Lewis, S. W., Murray, R. M., & Sham, P. C. (2003). Schizotypal personality traits in nonpsychotic relatives are associated with positive symptoms in psychotic probands. *Schizophrenia Bulletin*, *29*(2), 273-283. doi: 10.1192/bjp.161.5.610.
- Meehl, P. E. (1962). Schizotaxia, Schizotypy, Schizophrenia. *American Psychologist*, *17*, 827-838. doi: 10.1037/h0041029.
- Miettunen, J., Veijola, J., Freimer, N., Lichtermann, D., Peltonen, L., Paunio, T., ..., Ekelund, J. (2010). Data on schizotypy and affective scales are gender and education dependent - Study in the Northern Finland 1966 Birth Cohort. *Psychiatry Research*, *178*(2), 408-413. doi: 10.1016/j.psychres.2008.07.022.
- Miller, T. J., McGlashan, T. H., Rosen, J. L., Somjee, L., Markovich, P. J., Stein, K., & Woods, S. W. (2002). Prospective diagnosis of the initial prodrome for schizophrenia based on the structured interview for prodromal syndromes: Preliminary evidence of interrater reliability and predictive validity. *American Journal of Psychiatry*, *159*, 863-865. doi: 10.1176/appi.ajp.159.5.863.
- Mohr, C., & Claridge, G. (2015). Schizotypy do not worry, it is not all worrisome. *Schizophrenia Bulletin*, *41*(2), 436-443. doi: 10.1093/schbul/sbu185
- Patterson, T. L., Goldman, S., McKibbin, C. L., Hughs, T., & Jeste, D. V. (2001). UCSD performance-based skills assessment: Development of a new measure of everyday functioning for severely mentally ill adults. *Schizophrenia Bulletin*, *27*(2), 235-245. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11354591>.
- Peltier, B. D., & Walsh, J. A. (1990). An investigation of response bias in the Chapman scales. *Educational and Psychological Measurement*, *50*, 803-815. doi: 10.1177/0013164490504008.
- Rado, S. (1953). Dynamics and classification of disordered behavior. *American Journal of Psychiatry*, *110*, 406-416. doi: 10.1176/ajp.110.6.406.

- Raine, A. (1991). The SPQ: A scale for the assessment of schizotypal personality disorder based on DSM-III-R criteria. *Schizophrenia Bulletin*, 17(4), 555-564. doi: 10.1093/schbul/17.4.555.
- Raine, A. (1992). Sex differences in schizotypal personality in a nonclinical population. *Journal of Abnormal Psychology*, 101, 361-364. doi: 10.1037/0021-843X.101.2.361.
- Raine, A. (2006). Schizotypal personality: Neurodevelopmental and psychosocial trajectories. *Annual Review of Clinical Psychology*, 2, 291-326. doi: 10.1146/annurev.clinpsy.2.022305.095318.
- Rosell, D. R., Futterman, S. E., McMaster, A., & Siever, L. J. (2014). Schizotypal personality disorder: A current review. *Current Psychiatry Reports*, 16(7), 452-464. doi: 10.1007/s11920-014-0452-1.
- Rosso, I. M., Makris, N., Thermenos, H. W., Hodge, S. M., Brown, A., Kennedy, D., Caviness, V. S., ..., & Seidman L. J. (2010). Regional prefrontal cortex gray matter volumes in youth at familial risk for schizophrenia from the Harvard Adolescent High Risk Study. *Schizophrenia Research*, 123(1), 15-21. doi: 10.1016/j.schres.2010.06.015.
- Siever, L. G., & Davis, K. L. (2004). The pathophysiology of schizophrenia disorders: Perspectives from the spectrum. *American Journal of Psychiatry*, 161(3), 398-413. doi: 10.1176/appi.ajp.161.3.398.
- Solanki, R. K., Swami, M. K., Singh, P., & Gupta, S. (2012). Identification of vulnerability among first-degree relatives of patients with schizophrenia. *East Asian Archives of Psychiatry*, 22(3), 118-125. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/23019286>
- Spitzer, R. L., Endicott, J., & Gibbon, M. (1979). Crossing the border into borderline personality and borderline schizophrenia: The development of criteria. *Archives of General Psychiatry*, 36, 17-24. doi: 10.1001/archpsyc.1979.01780010023001.
- Spitzer, R., L., Williams, J. B. W., Gibbon, M., & First, M. B. (1990). *Structured clinical interview for DSM-III-R Axis II Disorders (SCID-II)*. Washington, D.C.: American Psychiatric Press.
- Steel, C., Marzillier, S., Fearon, P., & Ruddle, A. (2009). Childhood abuse and schizotypal personality. *Social Psychiatry and Psychiatric Epidemiology*, 44, 917-923. doi: 10.1007/s00127-009-0038-0.
- Stefanis, N. C., Smyrnis, N., Avramopoulos, D., Evdokimidis, I., Ntzoufras, I., & Stefanis, C. N. (2004). Factorial composition of self-rated schizotypal traits among young males undergoing military training. *Schizophrenia Bulletin*, 30, 335-350. doi: 10.1093/oxford-journals.schbul.a007083.
- Schürhoff, F., Laguerre, A., Fisher, H., Etain, B., Méary, A., Soussy, C., ..., Leboyer, M. (2009). Self-reported childhood trauma correlates with schizotypal measures in schizophrenia but not bipolar pedigrees. *Psychological Medicine*, 39(3), 365-370. doi: 10.1017/S0033291708003905.
- Tarbox, S. I. & Pogue-Geile, M. F. (2011). A multivariate perspective on schizotypy and familial association with schizophrenia: A review. *Clinical Psychology Review*, 31(7), 1169-1182. doi: 10.1016/j.cpr.2011.07.002.
- Torgersen, S., Onstad, S., Skre, I., Edvardsen, J., & Kringlen, E. (1993). "True" schizotypal

- personality disorder: A study of co-twins and relatives of schizophrenic probands. *American Journal of Psychiatry*, *150*, 1661-1667. doi: 10.1176/ajp.150.11.1661.
- Tsaousis, I., Zouraraki, C., Karamaouna, P., Karagiannopoulou, L., & Giakoumaki, S. G. (2015). The validity of Schizotypal Personality Questionnaire in a Greek sample: Tests of measurement invariance and latent mean differences. *Comprehensive Psychiatry*, *62*, 51-62. doi: 10.1016/j.comppsy.2015.06.003.
- Vollema, M. G., & Van Den Bosch, R. J. (1995). The multidimensionality of schizotypy. *Schizophrenia Bulletin*, *21*(1), 19-31. doi: 10.1093/schbul/21.1.19.
- Vollema, M. G., Sitskoorn, M. M., Appels, M. C., & Kahn, R. S. (2002). Does the Schizotypal Personality Questionnaire reflect the biological-genetic vulnerability to schizophrenia? *Schizophrenia Research*, *54*(1-2), 39-45. doi: 10.1016/S0920-9964(01)00350-4.
- Walder, D. J., Faraone, S. V., Glatt, S. J., Tsuang, M. T., & Seidman, L. J. (2014). Genetic liability, prenatal health, stress and family environment: Risk factors in the Harvard Adolescent Family High Risk for Schizophrenia Study. *Schizophrenia Research*, *157*(1-3), 142-148. doi: 10.1016/j.schres.2014.04.015.
- Wilkins, S. (1988). *Behavioural and psychopathological aspects of information processing in schizotypics*. (Unpublished doctoral dissertation). University of York.
- Williams, M. B. (1993). *The psychometric assessment of schizotypal personality*. (Unpublished doctoral dissertation). Institute of Psychiatry, University of London.
- Wuthrich, V., & Bates, T. C. (2005). Reliability and validity of two Likert versions of the Schizotypal Personality Questionnaire (SPQ). *Personality and Individual Differences*, *38*, 1543-1548. doi: 10.1016/j.paid.2004.09.017.
- Yaralian, P. S., Raine, A., Lencz, T., Hooley, J. M., Bihrlle, S. E., Mills, S., & Ventura, J. (2000). Elevated levels of cognitive-perceptual deficits in individuals with a family history of schizophrenia spectrum disorders. *Schizophrenia Research*, *46*(1), 57-63. doi: 10.1016/S0920-9964(99)00239-X.